Improving Shrub and Grass Fuel Maps Using Remotely Sensed Data to Support Fire Risk Assessments

Shrub and grassland ecosystems in the western United States are especially prone to fire events, yet available data for assessing fire risk in these areas are inadequate. The reasons for the difficulties in being able to effectively characterize shrub and grasslands for fire applications are varied and many, but part of the problem revolves around the high degree of intra- and inter-annual variability in fuel characteristics in these areas, necessitating higher level understanding of the dynamics of these systems. It is clear that we need to develop better understanding of the conditions that lead to wildland fire in shrub and grasslands. This information is of special importance to projects such as LANDFIRE, which has the goal of providing fire managers with nationally consistent and detailed spatial information about vegetation and fuel structure.

Through the support of the NASA Applied Sciences Program, we embarked on an assessment to derive better fuel characterizations in western US shrub and grassland ecosystems. Our primary objectives of the first phase of the project included the following: 1) Improve upon shrub and grassland mapping for fire applications; 2) Develop intra-seasonal (e.g. monthly) fuel data sets in shrub and grassland areas using a combination of Landsat and MODIS data; and 3) Determine if improvements in shrub and grassland data layers will alter and improve fire behavior model results.

While our long term goals are to expand our assessments to include all of the western United States, we are currently focused on an area in the Owyhee Basin of Idaho, Nevada and Oregon, and an eastern adjacent region, where access to additional field information collected by the US Bureau of Land Management was available. This area is the site of many large and frequent shrub and grassland fires. The shrubland areas are dominated by sagebrush (*Artemisia* spp), and the grassland areas have a substantial amount of cheatgrass (*Bromus tectorum*) associated with them (Figure 1).

Many fires occurred within the study area (Figure 2) from 1984 to present, and most but not all were in the shrub and grassland areas. We consider years 1985, 1996, 2005, 2006, 2007 and 2010 to be “high fire years”, when at least 1,500 km^2 burned within the study area.

Figure 1. Western US shrub systems. Left: Sagebrush ecosystem representing typical natural historic conditions. Right: Recently burned shrub system in the background with invasive grass cover in the foreground.

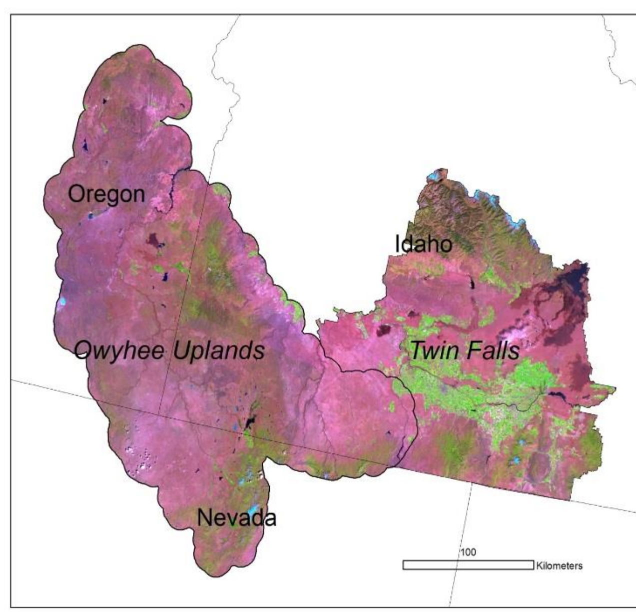

Figure 2. Landsat mosaic of Owyhee Upland and Twin Falls study area. Pink depicts areas dominated by shrub and grass vegetation. An agricultural zone is depicted by bright green near Twin Falls. A lava flow can be seen in upper right part of the mosaic.

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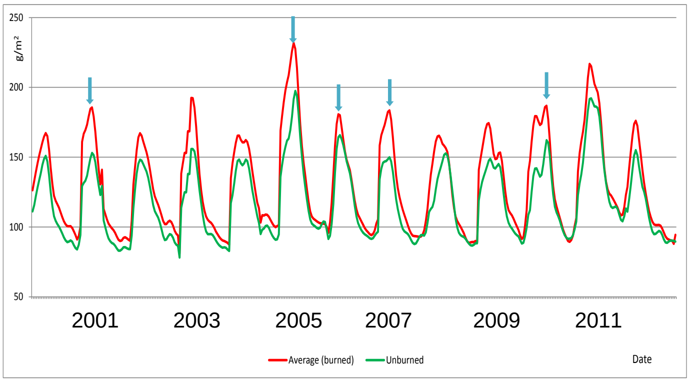

Figure 3. Seasonal live biomass profile for shrublands in the study region. Red indicates live biomass for sagebrush sites that have burned at least once between 1984 and 2010 according to the Monitoring Trends in Burn Severity (MTBS) project. Green indicates sites that did not burn during the time period. Blue arrows indicate high fire years.

MODIS Analyses

As depicted in Figure 3, the shrub and grassland areas of the region are characterized by high levels of biomass variability detectable through time series data analyses from the MODIS sensor. Those areas that have burned recently tend to have higher levels of biomass than those that have not. Understanding these patterns helps the fire management community to recognize which areas have high likelihood of burning in the future, thus enabling them to anticipate and plan accordingly.

Improving Grass and Shrub Fuel Maps To Support Fire Risk Assessments

Fire Behavior Fuel Models

Custom fire behavior fuel models for grasslands and shrubland were created to evaluate the impacts of surface fuel changes on fire behaviors. For comparison with the existing static fuels data, we also included the low-load, dry climate grass (GR2) and moderate load, dry climate grass-shrub (GS2) fire behavior fuel models from LANDFIRE. Then, we calculated 2 indices commonly used for fire management decisions: the Energy Release Component (ERC) and Flame Length (FL). Fire behavior indices and simulated burned area showed differences with fuel load estimates in different years. For instance, ERC and FL were predicted to be greater in years with high fuel loads (2005 and 2007) than years with low fuel loads (2008) in both grass and shrub vegetation types (see Table 1).

A Few Next Steps

Given the results from our first set of investigations, we are now initiating the second phase of the study. This will include: (1) expansion of our work to other western US shrub and grassland areas, (2) expanding our collaboration with external partners, including the Multi-Resolution Land Characteristics (MRLC) consortium and the Bureau of Land Management (BLM), and (3) transitioning the process into operations through interactions with LANDFIRE.

		Fuel load (ton ha^{-1})				
Fuel type	Fuel Load	Live herbaceous	Live woody	1-hour dead	ERC[1] (KJ m^{-2})	FL[2] (m)
Grass	High (2005)	3.27	0	3.92	10424.74	3.41
Grass	Moderate (2007)	2.6	0	4.5	10208.98	3.38
Grass	Low (2008)	2.08	0	0.45	3043.39	1.95
Grass	Default (GR2)	2.24	0	0.22	2952.54	1.92
Shrub	High (2005)	1.75	9.95	3.12	20043.21	3.23
Shrub	Moderate (2007)	1.3	9.64	3.52	19543.55	3.23
Shrub	Low (2008)	1.14	1.52	0.36	3770.17	1.58
Shrub	Default (GS2)	1.34	2.24	1.12	6347.96	2.16

Table 1. Fuel load values and simulated fire behavior indices for different fuel load scenarios. ERC is Energy Release Component, and FL is Flame Length. Default refers to fuel conditions as represented by LANDFIRE data set. Characterizing the intra- and inter-annual shrub and grass fuel loads is important for predicting ERC and FL, both of which are important to the fire management community.

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